



Presenters:

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Importance of Rice

- Billions of people depend on it
 - ▣ Most rice grown on small farms in southeast Asia
- Maximum crop yield requires transplantation
- Back-breaking work is done by dozens of farmers
- Rice Aid sought to design a lightweight, low-cost machine to transplant rice



<http://www.art.com/products/p14128611-sai2796530/pershause-craig-farm-worker-in-rice-paddy-vietnam.htm>

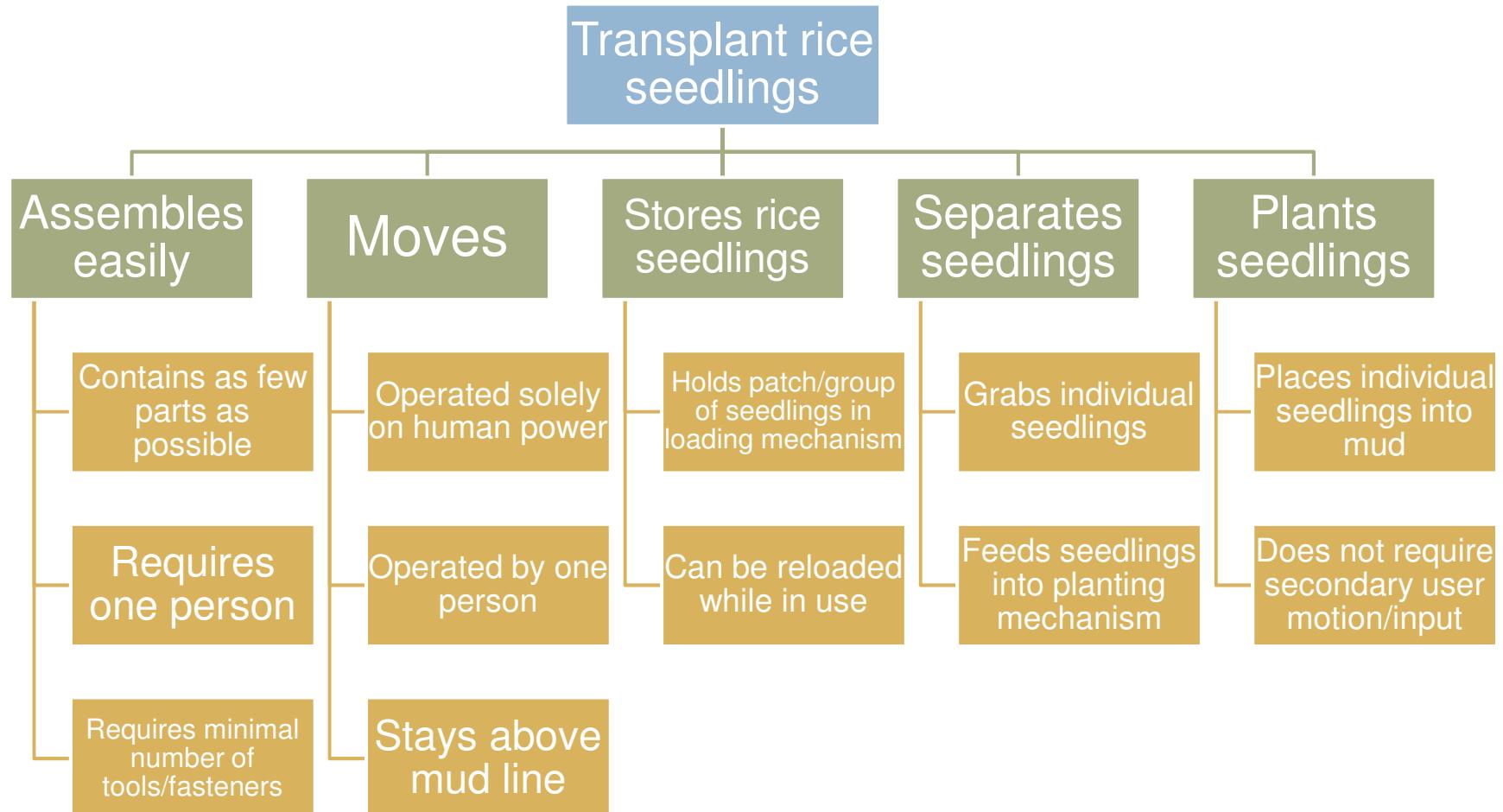
Existing Products



RICEAID'S DESIGN



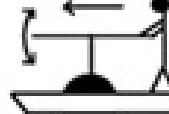
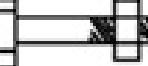
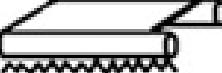
Function Tree



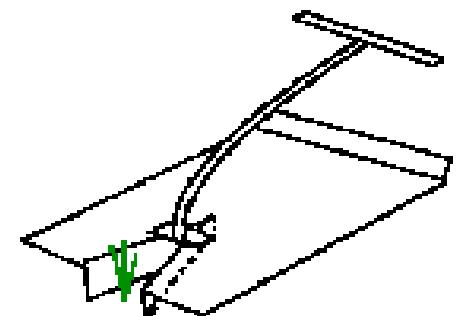
Design Specifications

Need/ Want	Specification	Details
N	Inexpensive	≈\$100
N	Lightweight	<35 lbs
N	Height of handle to fit average person	≈3 ft
W	Adjustable handle height	2.5 ft – 4.5 ft
N	Limited number of bolt sizes	≤3 bolt sizes
W	One standard bolt for entire machine	
N	Plants multiple rows at a time	2-3
N	Requires only one user	
N	Limited number of specialized parts	
W	No specialized parts	
N	Stores large number of seedlings	≈100 seedlings per tray
W	Stores additional seedlings other than main planting trays	
N	Requires no user input to trigger planting mechanism	
N	Ability to be pulled	
W	Ability to be pushed or pulled	
N	Plants seedlings at a fixed, constant rate	≈1 seedling/20 cm
W	Plants seedlings at a customizable constant rate	1 seedling/15-25 cm
N	Tray sized to fit average seedling height	≥7 inches
N	Rides above mud/water line	
N	Plants seedlings at a constant depth	≈2 inches
W	Plants seedlings at a customizable depth	1-3 inches
N	Minimizes parts that wear out easily	
N	Minimal water contact on planting ‘mechanism’	
N	Materials resist water damage	

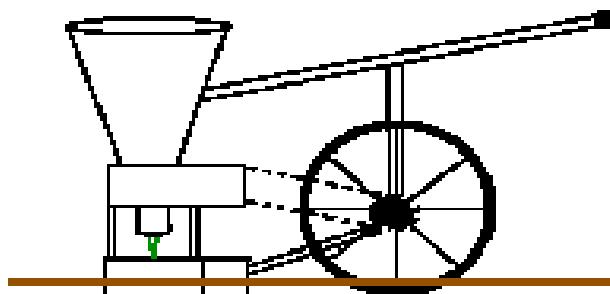
Morphological Chart

Requires one person and is operated solely by human power				
Requires minimal number of tools and fasteners	 Single Standard Bolt			
Stays above mud line				
Holds Patch/Group of Seedlings in loading mechanisms and feeds them into planting mechanism				Top View  Elastic Band
Can be reloaded while in use	 Ready to Plant			
Grabs Individual Seedlings and places into mud				
Does not require secondary user input				

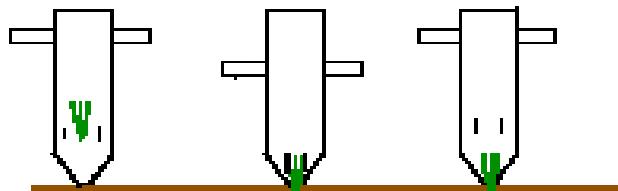
Design Ideation



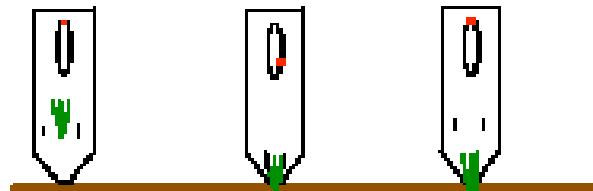
(1) Mud Spreader



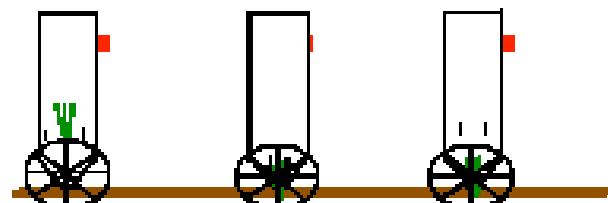
(2) Mud Cutter



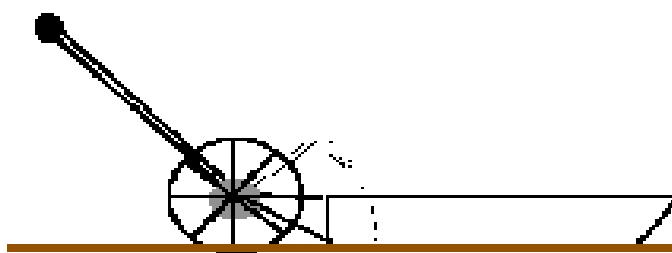
(3) Pogo



(4) Link and Track



(5) Mechanical Pencil



(5) Modified Box-Hopper Cart

Preliminary Analysis

- Constructed small scale “rice paddy”
- Determined seedling depth
- Funnel test
 - Bottleneck issue
- Plow test
 - Problems if water level is high
- Plunging fork
 - Not tested – products exist



Evaluation Matrix

		Criteria	Weight	Datum (Hand-crank)	Mud Spreader	Pogo	Mud Cutter	Link & Track	Modified Box-hopper	Mechanical Pencil
Assembles easily	Contains minimal parts	3	D a t u m	+	+	+	-	S	-	
	Requires one person	5		S	S	S	S	S	S	
	Requires minimal fasteners	2		+	+	+	+	+	+	
	Requires minimal tools	2		+	+	S	-	S	+	
	Entirely human powered	5		S	S	S	S	S	S	
	Stays above mud/water	3		S	S	S	S	S	S	
	Holds batch of seedlings in loading mechanism	3		-	S	S	-	S	-	
	Can be reloaded while in use	2		-	S	S	S	-	-	
	Grabs individual (small batch) of seedlings	5		-	S	S	S	S	S	
	Feeds seedlings into planting mechanism	5		-	S	+	-	+	S	
Plants seedlings	Places individual seedlings into mud	5		S	S	S	S	S	S	
	Does not require secondary operator input	3		-	+	+	+	+	S	
			Total +	0	3	4	4	2	3	2
			Total -	0	5	0	0	4	1	3
			Total S	0	4	8	8	6	8	7
		Overall Score	0	-2	4	4	-2	2	-1	
		Overall Weighted Score	0	-11	10	13	-7	8	-4	

MARKET RESEARCH RESULTS



Market Research Conclusions

- Bangladesh
- Cambodia
- India
- Indonesia
- Laos
- Thailand
- Vietnam

IRRI country offices

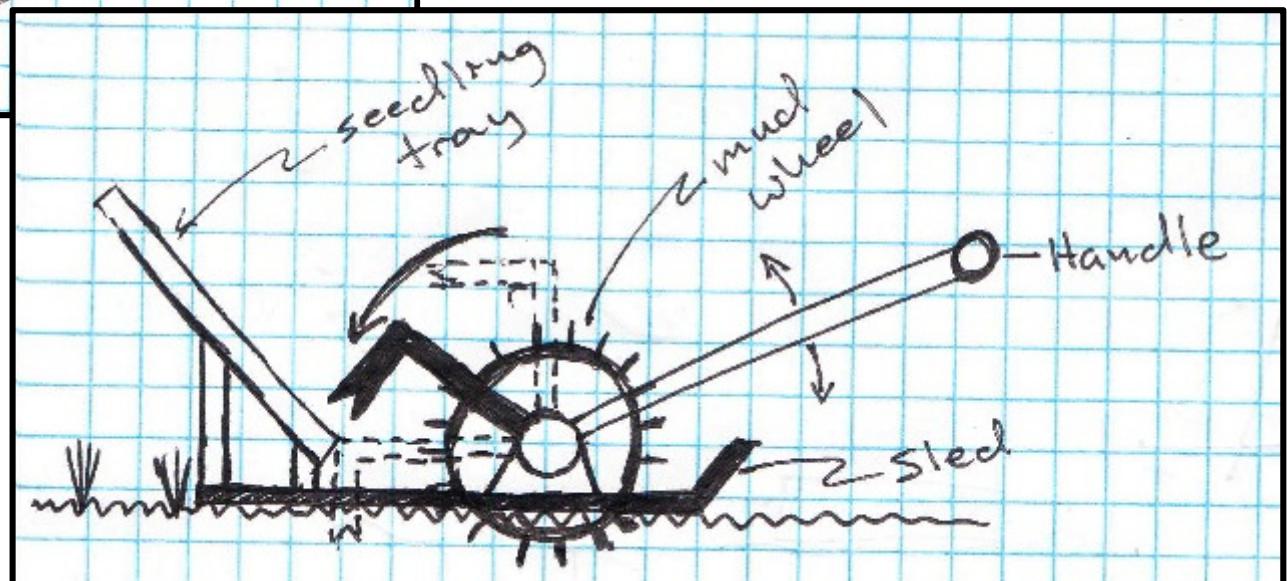
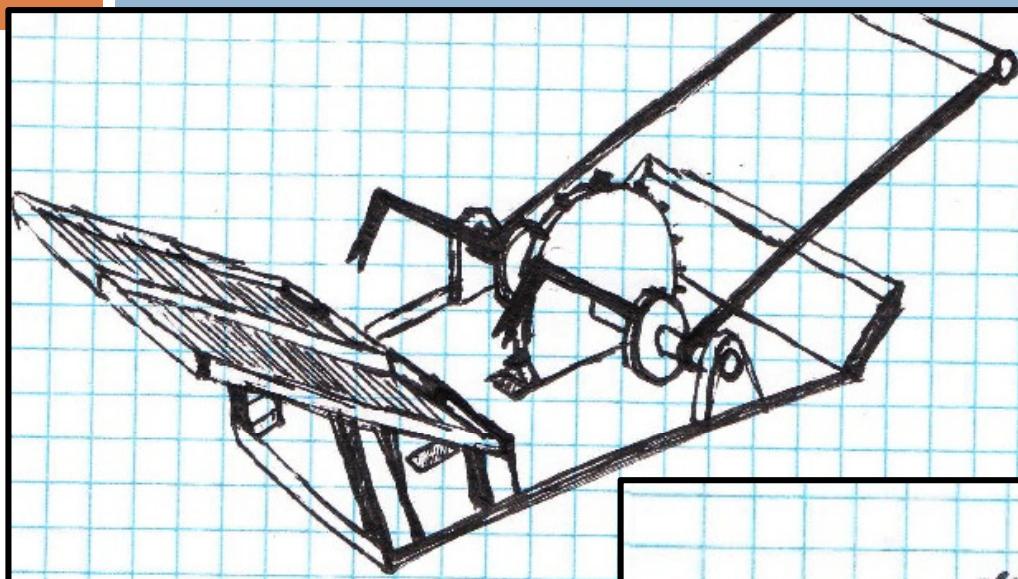


View [International Rice Research Institute \(IRRI\)](#) in a larger map

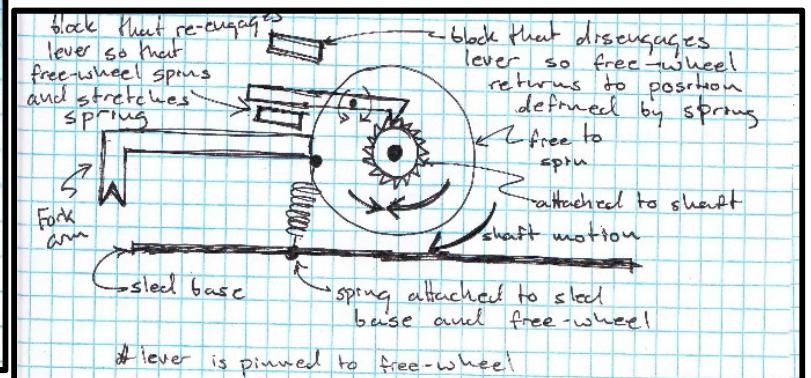
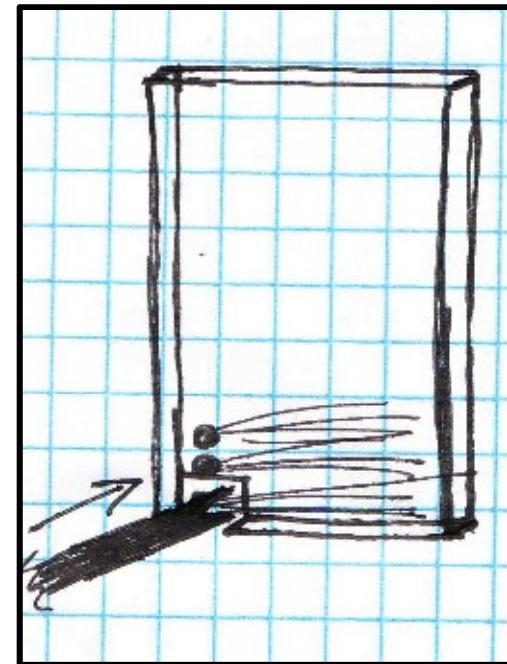
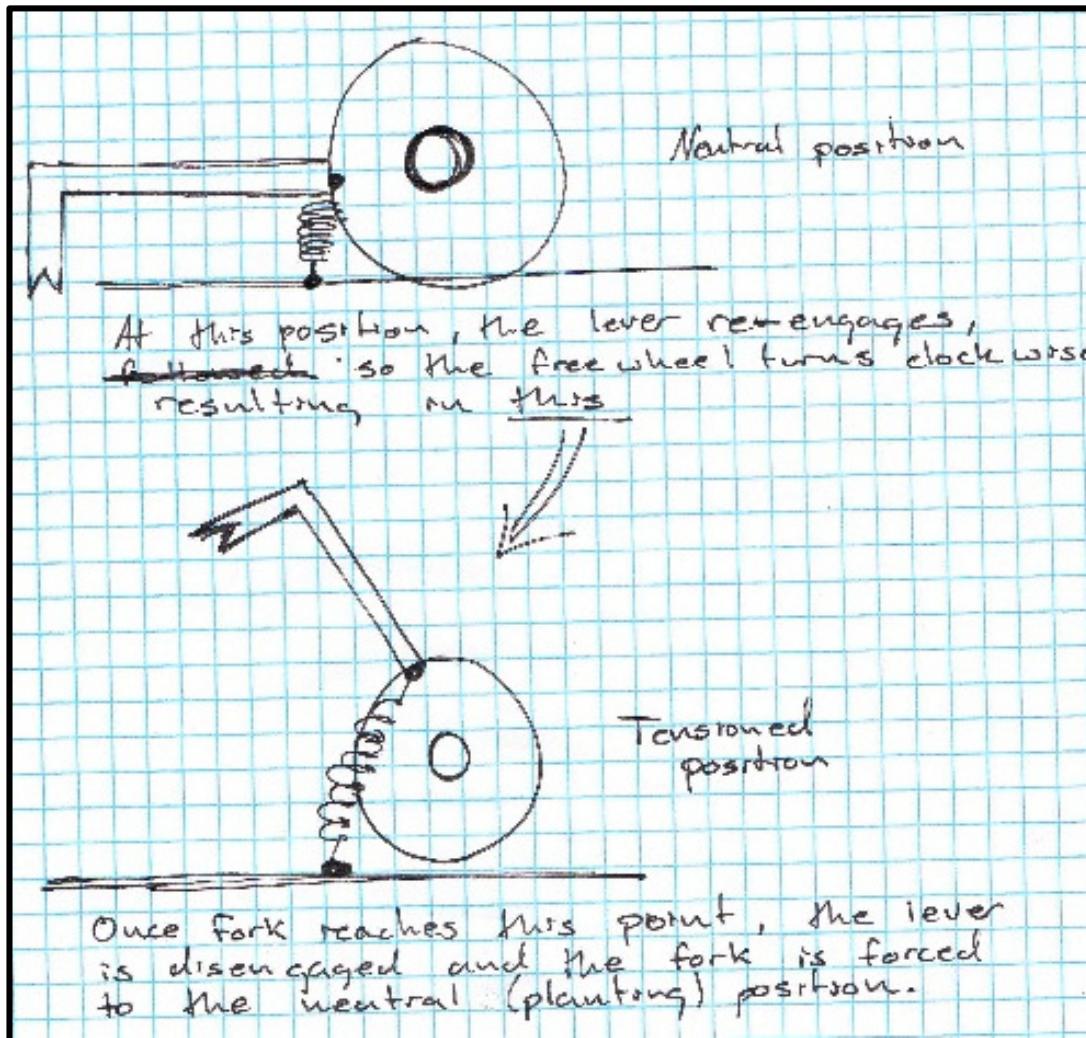
Results

- Labor shortage in southeast Asia
- Laos:
 - ▣ Mechanical transplanters are new
 - ▣ Mostly being used in Rice Research and Seed Production Centers
- Cambodia: good market for small machines
- Indonesia:
 - ▣ Transplanting usually done by women.
 - ▣ IRRI designed transplanter is too heavy.

Final Concept Selection

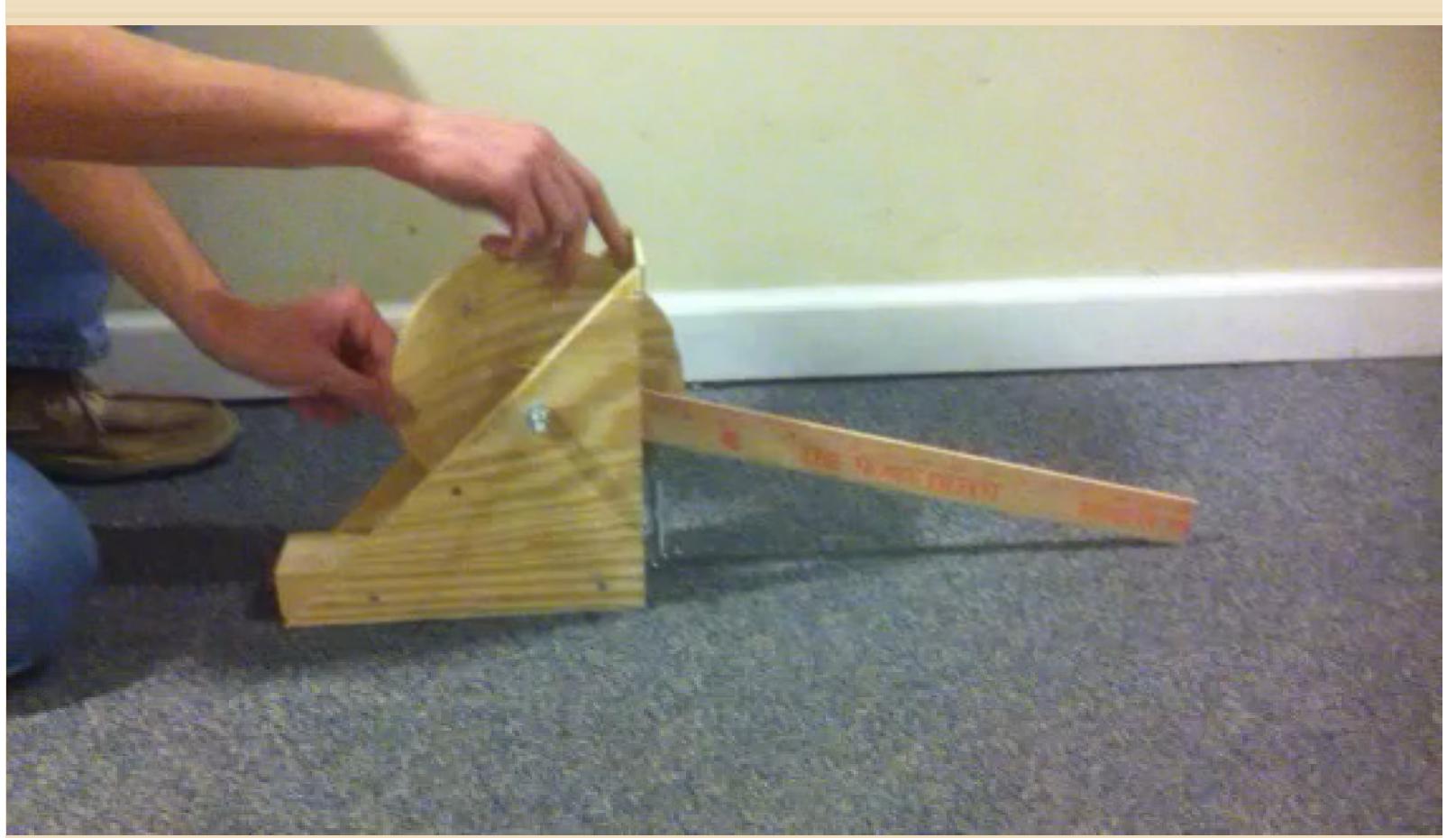


Planting Mechanism Selection



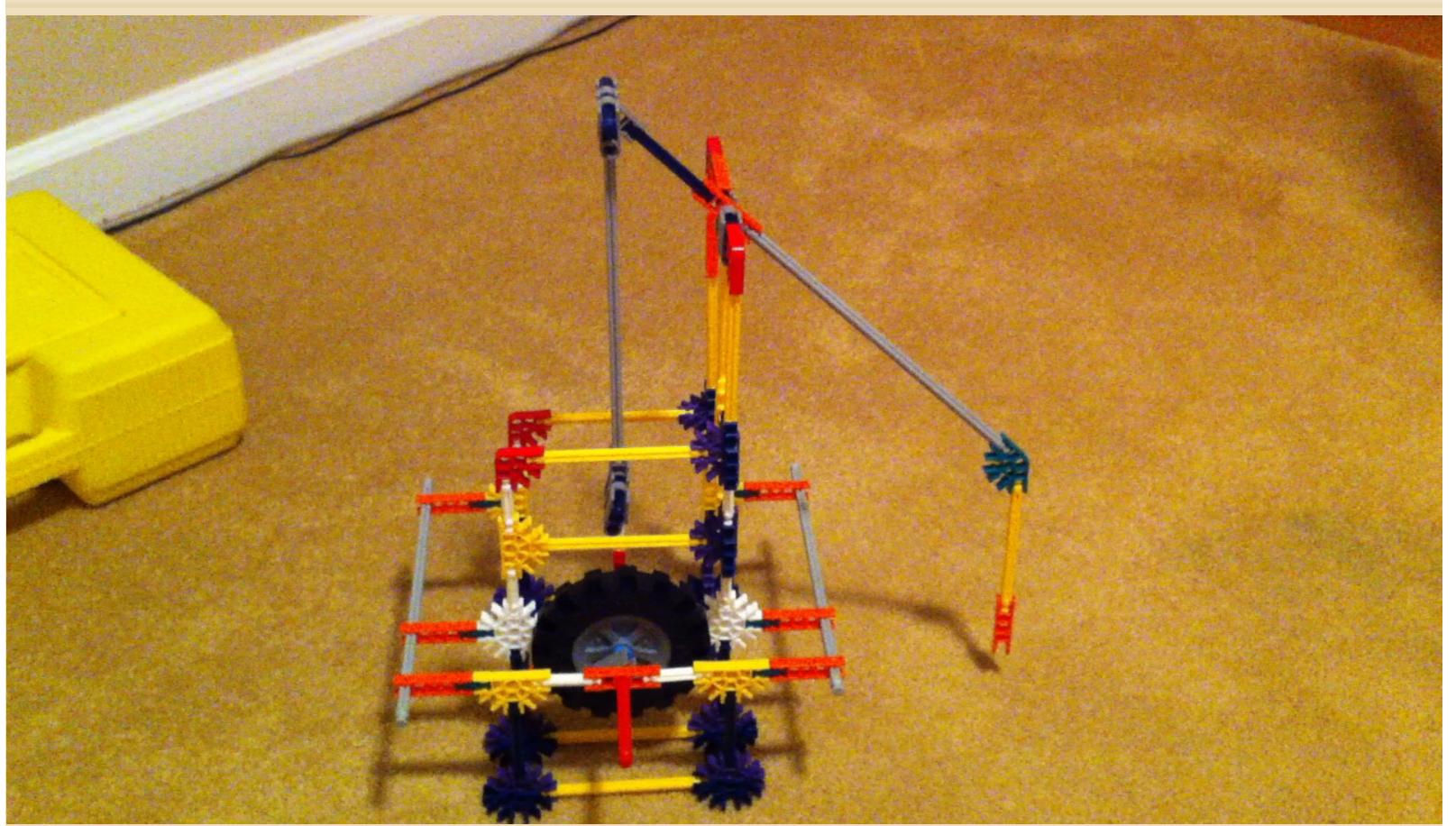
RICEAID'S PROTOTYPES





Proof of Concept Prototype

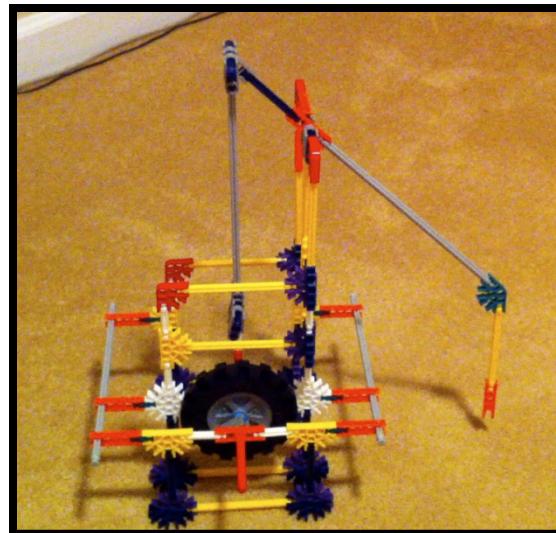
Simple mechanism operated by springs under tension to force planting arm/fork back to ground



Proof of Concept Prototype

Slightly more complex mechanism that utilizes a piston/crankshaft motion and a lever arm

Proof of Concept Prototypes



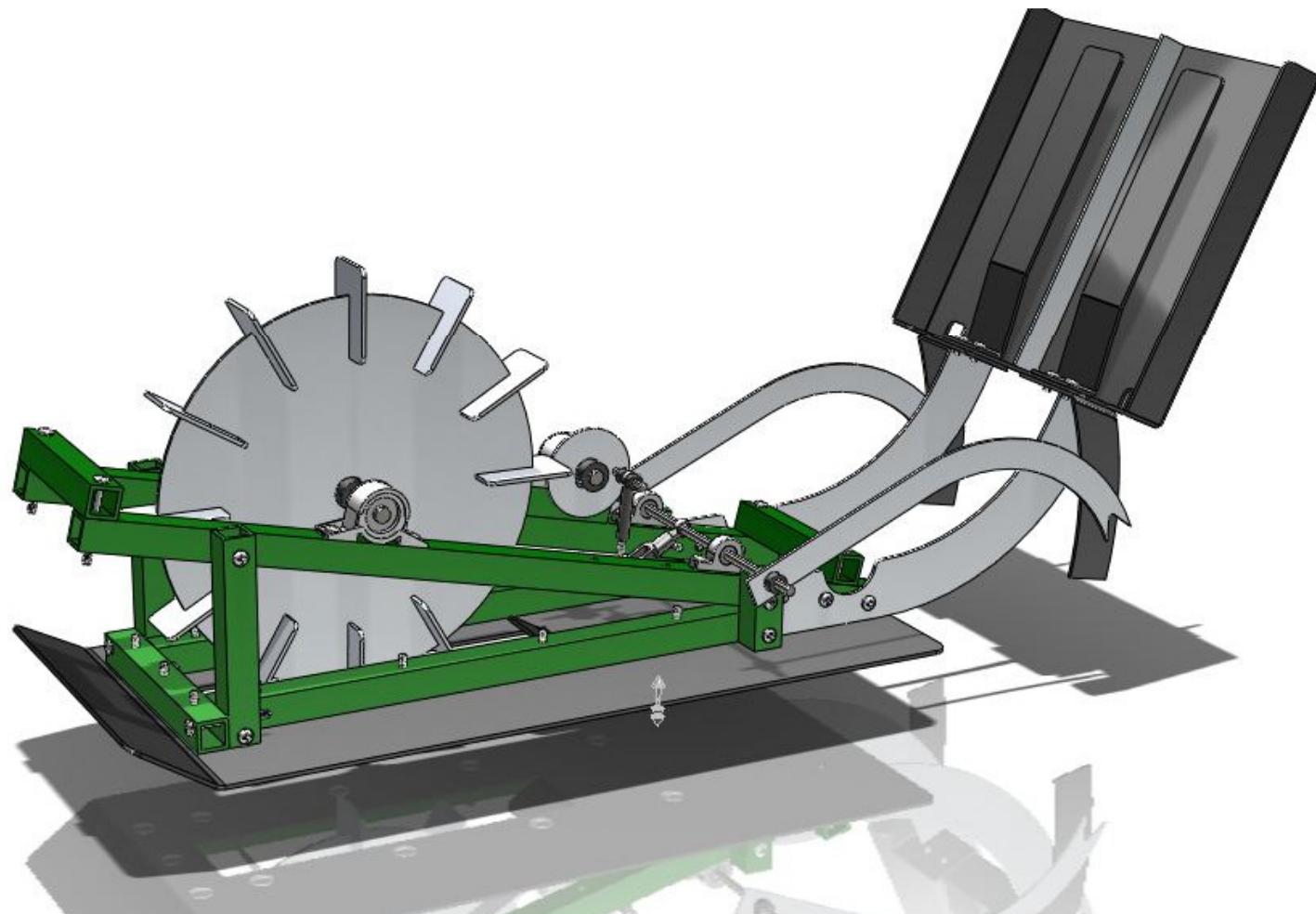
Justification of Final Design

- Main area of design is in the planting mechanism
- Rank two mechanisms relative to one another
- Performance, estimated cost, fulfillment of needs and wants, estimated maintenance required, etc.

CAD MODEL



CAD Model



PROTOTYPE TESTING



Testing Archives



Testing and Refinement



- Determined best way to pull the machine
- Cut a slot out of the tray to allow mud flow
- Modified restraint arms in tray for better planting
- Raised the tray closer to the planting arms

CONCLUSIONS



Safety and Risk Assessment



- Risk is centered around materials on machine
 - ▣ Sharp forks that pick off rice seedlings
 - ▣ Use of fillets to reduce sharp edges that may cut when handling
- Transportation is simple
 - ▣ Sharp forks fold back
 - ▣ Two accessible handles for carrying

Materials and Manufacturing

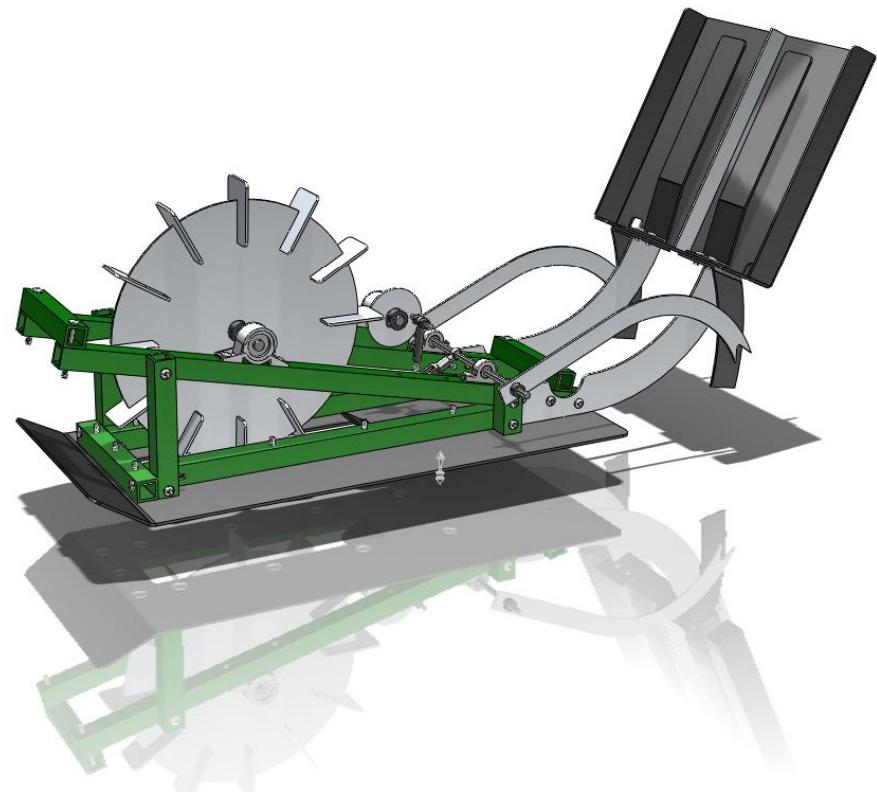
- Simple materials
 - Aluminum tubing
 - Aluminum sheet metal
 - ABS plastic sled/tray
 - Off-shelf parts
 - All 1/4" bolt holes
 - 3 different lengths
- Manufacturing
 - Cutting of flat stock
 - the only specialized process
 - Replace plastic with sheet metal and eliminate costs
 - Joining by nuts and bolts

Materials Cost

Part	Pro-rated Price
Aluminum stock	\$58.23
Plastic stock	\$16.67
Bearings	\$32.23
Shafts, collars, etc.	\$33.40
Sprockets, Chain	\$16.62
Linkage system	\$17.50
Hardware	\$8.47
Misc.	\$2.96
Total	\$186.03

Industrial Design

- Simple, mechanical device
- Less focus on visual design
 - Working with non-profits to reach target market
- Focus on user interface
 - Weight requirements
 - Adjustable height for different sized users



Societal Impact



- Help with current labor shortage in southeast Asia
- Use existing manufacturing facilities in Asia that have these kinds of capabilities
- Utilize cheap materials
 - ▣ Polycarbonate, sheet metal, delrin
- Users can recycle machine at end of life
 - ▣ Aluminum can be recycled endlessly

Summary – To Date

- Built full-size working prototype
- Tested prototype in various conditions
- RiceAid design meets specs:
 - Lightweight
 - Speedy, plant multiple rows
 - Efficient
 - Low Cost
- Commercialization?



Conclusions and Future Work

- Prototype is close to being a *fully* functioning transplanter
- Areas of future improvement:
 - ▣ Slight re-design for more torque in planting arms
 - ▣ Deeper, wider paddles on wheel for torque and better rotation
 - ▣ Focus on mechanism to feed seedlings into planting position
- Contact IRRI and other non-profits for distribution and manufacturing options.



QUESTIONS?